REMARKS

Applicants have amended their claims so as to set forth claim 4 in independent form, and so as to add new claims 5 and 6 to the application. Claims 5 and 6, dependent respectively on claims 1 and 5, respectively recites that the conductor paste includes at least one selected from the group consisting of platinum and palladium, and defines an amount of such platinum and/or palladium included in the conductor paste (with respect to function thereof). Note, for example, page 6, lines 8-11, of Applicants' specification.

Applicants respectfully traverse the rejection of their claims being considered on the merits in the above-identified application under 35 USC §103, as set forth in Item 7 on pages 3-5 of the Office Action mailed November 14, 2002, and respectfully submit that all claims presently in the application and being considered on the merits patentably distinguish over the teachings of the references applied in the Office Action mailed November 14, 2002, that is, the teachings of the U.S. patents to Kodera, et al., No. 6,338,893, and to Lautzenhiser, et al. No. 5,527,627, under the provisions of 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such an electronic component as in the present claims, including, inter alia, wherein the conductor film is formed using a conductor paste which does not contain any glass and which contains a silver particle having a specific surface area of $0.3m^2/g$ to $3.0m^2/g$, and, moreover, wherein the firing for forming the conductor film is at a temperature having a difference of $\pm 50°C$ from a softening temperature of the glass of the ceramic board. See claim 1; note also claim 4.

It is respectfully submitted that these references would have neither taught nor would have suggested the unexpectedly better results achieved in solder wettability to the conductor film, and bonding strength of the conductor film to the ceramic board containing glass, achieved using the conductor paste containing silver particles having the specified surface area, and firing temperature relative to softening temperature of the glass of the glass ceramic board, according to the present invention, as shown in the evidence in the original disclosure of the above-identified application. In this regard, it is respectfully submitted that this evidence of unexpectedly better results established by the evidence of record in the above-identified application must be considered in determining patentability of the present invention. See *In re DeBlauwe*, 222 USPQ 191 (CAFC 1984).

The present invention is directed to a glass ceramic board with a silver-based conductor pattern on the surface thereof; and, in particular, is directed to providing such glass ceramic board with conductor film thereon, wherein solder wettability to the conductor film is good, a bonding strength of the conductor film to the glass ceramic board is great and a bond of a gold wire with the conductor film is reliable.

As described in the paragraph bridging pages 1 and 2 of Applicants' specification, where the conductor pattern on the surface of a low temperature co-fired ceramic multilayer printed circuit board is formed of a silver-based conductor, it is difficult to provide good solder wettability and good bonding strength to the board, while providing a reliable bond with a gold wire. Applicants have found that by utilizing a conductor paste containing silver particles having a specific surface area of $0.3m^2/g$ to $3.0m^2/g$, as the paste for forming the silver-based conductor film, and by firing such paste at a temperature having a difference within 50°C (either greater

than or less than) of the softening temperature of glass of the glass ceramic board, the goals of good solder wettability, good bonding strength of the conductor film to the board and reliable bonding with a gold wire are achieved.

That is, as seen in Fig. 2 of Applicants' disclosure, and described in the paragraph bridging pages 9 and 10 of Applicants' specification, the present inventors have found that solder wettability changes in accordance with 1) the temperature difference between the firing temperature and the softening temperature of the borosilicate in the ceramic board, and 2) the particle size of silver particles in the conductor paste. Specifically, it was found out that, when a specific surface area of the silver particle is $0.3m^2/g$ or more, the silver-based conductor film, whose ratio of solder diameters after reflow relative to that before reflow, as a percentage, is 95% or more, can be formed by firing with a firing temperature which is different from the softening temperature of the borosilicate by 50°C or less.

Furthermore, as seen in Fig. 3 and the corresponding description in the paragraphs bridging pages 10 and 11, and pages 11 and 12, of Applicants' specification, the present inventors have found by experiments that a tensile strength changes in accordance with the specific surface area of the silver particle in the conductor paste. If the specific surface area of the silver particle is more than $5m^2/g$, the tensile strength between the ceramic board and a bonding pad formed from the conductor paste is insufficient. Moreover, if the specific surface area of the silver particle is from $0.3m^2/g$ to $3.0m^2/g$, sufficient tensile strength between the ceramic board and the pad is achieved by firing at the firing temperature which is different from the softening temperature of the borosilicate by 50°C or less.

Thus, by utilizing a conductor film formed by firing at the temperature as set

forth in the present claims, and by utilizing a conductor film formed from conductor paste with silver particles having the specific surface area as in the present claims, the objectives according to the present invention are achieved. Particularly in view of these objectives unexpectedly achieved according to the present invention, clearly the presently claimed subject matter patentably distinguishes over the teachings of the applied prior art.

Kodera, et al. discloses a conductive paste used for a ceramic printed circuit substrate formed of a glass ceramic, and a ceramic printed circuit substrate that uses this conductive paste. The conductive paste includes specific amounts of silver-platinum; manganese dioxide; copper oxide; silicon dioxide having a specific surface area of not less than $50m^2/g$ as measured by a BET method, an average primary grain size of 5-50nm and a purity not lower than 99.8%; and molybdenum and tungsten powder. See column 4, lines 6-14. Note also column 4, lines 15-35, describing advantages of use of the manganese dioxide, silicon dioxide powder, copper oxide, molybdenum and tungsten powder, and absence of glass frit. This patent discloses that the ceramic printed circuit substrate includes an insulation portion formed of glass ceramic containing lead borosilicate glass as a glass component and a circuit portion containing silver as the main component, with at least part of the circuit portion being formed by use of the above-described conductive paste. This patent discloses that simultaneous firing is performed to form the ceramic printed circuit substrate and circuit conductor. See column 4, line 66 to column 5, line 37.

It is noted that Kodera, et al. discloses primarily use of a conductive paste including specified components, the components including, inter alia, silicon dioxide

powder. It is respectfully submitted that this reference does not disclose, nor would have suggested, a conductor film formed by firing the conductor paste as in the present claims, including specific surface area of silver particles of the conductor paste and temperature at which the conductor paste is fired, and advantages achieved thereby as discussed in the foregoing.

In addition, it is emphasized that Kodera, et al. discloses the absence of glass frit, to improve solder wettability, but includes, inter alia, silicon dioxide in the conductive paste. It is respectfully submitted that this disclosure in Kodera, et al. would have neither taught nor would have suggested the conductor film formed by firing a conductor paste, which does not contain any glass, and also contains the silver particles having the specific surface area, with the paste being fired at the specified temperature, as in the present claims.

It is respectfully submitted that the additional teachings of Lautzenhiser, et al. would not have rectified the deficiencies of Kodera, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Lautzenhiser, et al. discloses ultra-thick thick films which are capable of conducting and dissipating heat for purposes of thermal management of semiconductor devices. The thick films are formed using an ink composition formulated to enable the ultra-thick thick film to be formed as a single layer, such that only a single print, dry and fire cycle is required to form the film. See column 1, lines 15-17; note also column 2, lines 47-54. This patent discloses that the ink composition is preferably composed of a powder mixture and an organic binder mixture which has been dissolved in a suitable solvent, the powder mixture

preferably constituting about 87-94 wt.% of the ink composition and including a silver powder having an effective surface area of not greater than about $0.35m^2/g$ so as to promote porosity of the ink composition. See column 3, lines 6-13. Note also the paragraph bridging columns 4 and 5 of this patent; column 5, lines 15-17; and column 6, lines 57-59.

Initially, it is respectfully submitted that the teachings of Lautzenhiser, et al. are not properly combinable with the teachings of Kodera, et al. In this regard, note that Kodera, et al. is concerned with ceramic printed circuit substrates having a surface circuit pattern, while Lautzenhiser, et al. is concerned with ink compositions capable of conducting and dissipating heat. It is emphasized that Lautzenhiser, et al. is concerned with heat conductivity, not electrical conductivity, for thermal management of semiconductor devices. In view of the different technologies involved in Kodera, et al. and in Lautzenhiser, et al., and further in view of the different problems addressed by each, it is respectfully submitted that one of ordinary skill in the art concerned with in Kodera, et al., would not have looked to the teachings of Lautzenhiser, et al. In other words, it is respectfully submitted that Kodera, et al. and Lautzenhiser, et al. are directed to non-analogous arts. That is, it is respectfully submitted that one of ordinary skill in the art concerned with in Kodera, et al. (ceramic printed circuit substrates having conductive films formed thereon which are formed from a conductive paste) would not have looked to the teachings of Lautzenhiser, et al. to address problems which are addressed in Kodera, et al.

In addition, it is respectfully submitted that the Examiner has not provided any proper motivation for combining the teachings of Kodera, et al. and Lautzenhiser, et

al. In this regard, the contention by the Examiner that while Kodera, et al. does not disclose the specific surface area of the silver particles, it would have been obvious to modify the printed circuit substrate of Kodera, et al. with the ink composition of Lautzenhiser, et al. as the ink composition, is respectfully traversed. It is respectfully submitted that one of ordinary skill in the art concerned with in Kodera, et al. would not have been motivated to look at the ink composition of Lautzenhiser, et al. for forming an ultra-thick thick film suitable for conducting heat laterally.

In any event, even assuming, arguendo, that the teachings of Kodera, et al. and Lautzenhiser, et al. were properly combinable, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including range for the specific surface area of silver particle, and the firing temperature used in providing the conductor film, and unexpectedly better results achieved by the present invention due thereto as discussed in the foregoing.

With respect to specific surface area, note that Lautzenhiser, et al. discloses a specific surface area not greater than about $0.35m^2/g$ "so as to promote the porosity of the ink composition". Such small overlap in Lautzenhiser, et al., even if properly combinable with the teachings of Kodera, et al., would have neither taught nor would have suggested the range of specific surface area as in the present claims, and unexpectedly better advantages achieved thereby.

In addition, the Examiner admits that Kodera, et al. and Lautzenhiser, et al. do not specifically disclose the temperature difference between the firing temperature of the conductor paste and the softening temperature of the glass, but contends that since the green sheets and the printed circuits can be printed at the same time in Kodera, et al., this satisfies the difference. Applicants respectfully

traverse this contention by the Examiner that because the green sheets and the printed circuits can be printed at the same time, this satisfies the firing recitation as in the present claims. It is respectfully submitted that there is no disclosure in Kodera, et al. and Lautzenhiser, et al., either alone or in combination, as to difference between the softening temperature of the glass in the substrate and the firing temperature of the conductive paste utilized in forming the recited conductive film. It is respectfully submitted that the simultaneous firing as in Kodera, et al. would not inherently satisfy the firing temperature according to the present claims, or from the same product. Thus, clearly the Examiner has not established obviousness of the film formed utilizing a firing of the conductor paste as in the present claims.

In addition, particularly in light of the unexpectedly better results achieved through use of a conductor film formed by firing at a temperature as in the present claims, as established by the evidence in the specification of the above-identified application and discussed previously, it is respectfully submitted that Applicants have clearly established unobviousness of the presently claimed subject matter.

Again, it is emphasized that the present invention, utilizing a conductor film formed from a conductor paste having silver particles with a specific surface area of $0.3m^2/g$ to $3.0m^2/g$, without including any glass, and which is formed by firing performed within a range of $\pm$50°C from the softening temperature of the glass included in the ceramic board, provides a conductor film having unexpectedly better properties of good solder wettability and high adhesion strength with the ceramic board, as seen by the evidence in Applicants' original disclosure and discussed previously. Clearly, these unexpectedly better results establish patentability under 35 USC §103 over the teachings of Kodera, et al. and Lautzenhiser, et al.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application and being considered on the merits therein, are respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current Amendment. The changes are shown on the enclosed Attachment-1, captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 566.40595X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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Attachment-1

VERSION WITH MARKINGS TO SHOW CHANGES MADE

4. (Amended) An electronic component which has a conductor film formed on a glass ceramic board, formed by [the] a method comprising the steps of:

sticking a conductor paste containing a silver particle having a specific surface area of $0.3m^2/g$ to $3.0m^2/g$ and no glass onto a glass ceramic sheet board which has not been sintered or has been sintered; and

firing the conductor paste at a temperature having a difference of $\pm$50°C from a softening temperature of the glass of the glass ceramic board and for forming the conductor film on the glass ceramic board [of claim 3].